MRI

DERMAL TRANSFER OF PCBs FROM SURFACES

DRAFT INTERIM REPORT NO. 5
Task 37

EPA Prime Contract No. 68-02-3938
MRI Project No. 8501-A(37)

March 28, 1986

Prepared for:

U.S. Environmental Protection Agency
Office of Toxic Substances
Field Studies Branch (TS-798)
401 M Street, S.W.
Washington, DC 20460

Attn: Mr. Daniel T. Heggem
Work Assignment Manager

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By

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Maxine Stoltz
Mitchell D. Erickson

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PREFACE

This report was prepared for the Environmental Protection Agency under EPA Contract No. 68-02-3938, Work Assignment No. 37. The research was conducted in the Pharmacology and Toxicology Section of Midwest Research Institute during the period January 27 - March 28, 1986. The studies were performed by Kris Christianson, Assistant Biologist, with assistance from Leigh Labor, Technician. The HPLC analysis was performed by Larry Litle, Junior Chemist, and Frank Pallas, Associate Chemist. The study director was Maxine Stoltz, Associate Biochemist, and the work assignment leader was Mitchell D. Erickson, Principal Chemist. Joseph J. Breen, Karen Hammerstrom, Denise Keehrern, Jone Kim, C. J. Nelson, and Daniel T. Heggem of the Office of Toxic Substances provided helpful guidance.

MIDWEST RESEARCH INSTITUTE

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I. INTRODUCTION

A. Background

The U.S. Environmental Protection Agency (EPA), under the authority of the Toxic Substances Control Act (TSCA) Section 8(e), has determined that spills involving polychlorinated biphenyls (PCBs) must be reported, controlled, and cleaned up whenever the spill incident poses a substantial risk to human health or the environment. The Office of Toxic Substances (OTS) has been asked to establish a national spill cleanup policy. In assessing the risk of residual PCBs after a spill cleanup, OTS must estimate the potential human exposure to PCBs via dermal contact. To provide data for use in this exposure assessment, MRI evaluated the amount of PCBs that were transferred under various contact times to skin from two different surfaces.

B. Objectives

The objective of this study was to determine the amount of PCBs on two different surfaces transferred *in vitro* to skin during various contact times. The surfaces were glass and painted steel that were spiked with 6.25 µg/6.25 cm^2 (100 µg/100 cm^2) ^{14}C-PCB. Pig and human skin (3 x 3 cm pieces) were contacted with both types of surfaces under a static load of 5 lb/in^2 (psi) (3.2 kg/9 cm^2) for 60 min, 1 min or 6 x 1 min (10 min between each minute contact) (Figure 1). This study was a limited preliminary screening study with two surfaces, two types of skin, one pressure condition, one PCB congener, and three time conditions.

II. SUMMARY

This report describes the results of experiments conducted to determine the fraction of PCBs that were transferred *in vitro* under various contact conditions to pig or human skin from glass and metal surfaces. The results indicate that a considerable amount of the ^{14}C-PCB applied to the surfaces at

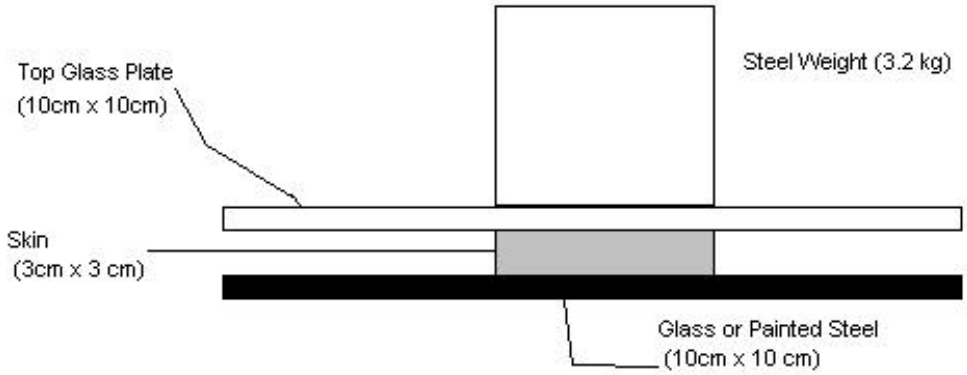

Figure 1. Experimental set up for skin surface contact.

l00 µg/l00 cm^2 was transferred to the skin. The pig and human skin (3 x 3 cm pieces) were contacted with glass or painted metal surfaces spiked with 6.25 µg/100 µL of a single ^{14}C-PCB congener under 5 psi for 60 min, 1 min, and 6 x 1 min.

For experiments with pig skin on glass, ~ 32% of the applied sample was transferred to the skin after 60 min, ~ 21% after 1 min, and ~ 44% after 6 x 1 min. From metal surfaces, ~ 16% was transferred to skin after 60 min, 6% after 1 min, and 35% after 6 x 1 min.

Experiments with human skin on glass showed that 63-84% of the applied radioactivity was transferred during a 60-min contact period, 35-64% in 1 min, and 22-52% after 6 x 1 min. From metal surfaces, ~ 48% was transferred in 60 min, ~ 34% in l min, and ~ 32% after the 6 x l min contact periods.

III. EXPERIMENTAL

A. Surfaces Tested

Glass and painted steel cut into approximately 10 x 10 cm pieces were used as the test surfaces. The glass was approximately 5 mm thick and the metal was approximately 1 mm thick. The glass was typical plate glass, obtained locally. The steel was painted gray and was obtained from discarded office furniture. The surfaces were thoroughly washed with warm water and Alconox®, laboratory detergent, rinsed with tap water followed by distilled water, then rinsed with reagent grade acetone and allowed to dry before rinsing with pesticide residue grade hexane. The clean surfaces were stored in a closed cardboard box until used. A diamond pencil was used to mark a 2.5 x 2.5 cm area (total surface area, 6.25 cm^2) on the surface. Each surface was also marked with a different identification number using a diamond pencil.

B. Skin Tested

Pig and human skin were used for these studies. Frozen pig skin (ten 8 x 10 cm pieces) was purchased from Genetics Laboratory (St. Paul, Minnesota) and was stored at -20°C according to the supplier's instructions. Frozen human skin (ten 5 x 17 cm pieces) was purchased from the Shriner's Burn Institute (Cincinnati, Ohio) and was stored at -80°C according to the supplier's instructions. The skin pieces, in individually sealed bags, were thawed according to the supplier's instructions by placing the sealed bag in a 35 to 40°C water bath for 5 min. The skin was removed from the bag and cut into 3 x 3 cm pieces with a razor blade. The skin pieces were blotted with gauze to remove excess moisture and were then weighed on a Mettler PC440 balance before placing on the test surface. The skin weights were recorded in a laboratory notebook. Thawed skin was kept at ~ 4°C and was used within 24 h.

C. Chemicals

Carbon-14 labeled 2,4,5,2',4',5'-hexachlorobiphenyl was supplied to Midwest Research Institute (MRI) through Pathfinder Laboratories, Inc. (St. Louis, Missouri). On January 17, 1986, MRI received 0.5 mCi of the labeled compound (Lot No. 125F9205) with a specific activity of 9.4 mCi/mmol, dissolved in 500 µL of toluene and packaged in a sealed ampule. The radiochemical purity was specified by the supplier to be 98% by reverse phase high performance liquid chromatography (HPLC), and confirmed by MRI analysis, described below. Upon receipt of the labeled compound, it was stored at ~ 4°C. The compound was diluted 1:1 with toluene, yielding a concentration of 19.4 mg/mL. The ^{14}C-PCB spiking solution was prepared by adding 20 µL of the 19.4 mg/mL solution to 6.11 mL of hexane (reagent grade) to yield a concentration of 6.25 µg/100 µL.

A non-labeled 2,4,5,2',4',5'-hexachlorobiphenyl standard was supplied through Ultra Scientific (Hope, Rhode Island). On February 2, 1986, 150 mg of the compound (code no. RPC-047) was received. The chemical was stored at ~ 4°C.

1. HPLC Chromatographic System

HPLC instrumentation included a Perkin Elmer Series II LC fitted with a Whatman Partisil 5 ODS-3 column (4.6 x 250 mm). Water (containing 0.5% glacial acetic acid) and acetonitrile were used isocratically as the eluting solvents. Introduction of the analyte onto the column was performed manually by the use of a Rheodyne 7125 valve. The eluate was monitored for ultraviolet absorption at 254 nm with a Waters 440 ultraviolet detector. Eluting fractions were collected with an ISCO Model 328 (Instrumentation Specialties Co.) for the detection of radioactivity. Eluate fractions were combined with phase combining scintillate (Amersham Corporation, Arlington Heights, Illinois). Scintillation counting was performed in a Packard TriCarb Model 4530. Scintillation data were applied manually to a BASIC program written for a Radio Shack TRS-80 Model I (Tandy Corporation) computer. A radiochemical profile was generated and peaks were integrated by this same program.

2. HPLC Analysis

An aliquot (12 µL) of the radiolabeled compound (19.4 mg/mL) was allowed to air dry (toluene evaporate off), then 1.0 mL of acetonitrile was added to the dried sample and sonicated to yield a concentration of 0.230 mg/mL. A non-labeled standard was prepared in acetonitrile at a concentration of 0.227 mg/mL. A 10-µL aliquot was then analyzed by the HPLC chromatographic system described earlier.

Analysis of the ^{14}C-PCB labeled solution by a reverse phase HPLC, performed at MRI (paralleling Pathfinders), showed 98.8% radiochemical purity and 97.5% chemical purity by ultraviolet detection.

D. Experimental Design

As described in the work plan ("Dermal Transfer of PCBs from Surfaces," February 14, 1986), glass and metal surfaces spiked with ^{14}C-PCB

(6.25 µg/6.25 cm^2) were contacted with pig and human skin for 1, 60, and 6 x 1 min (10 min between each minute contact) at a static load of 5 psi on the skin surface area. The skin was placed over the spiked area on the surface. A clean glass plate was placed over the skin and the appropriate pressure applied.

Spiked and blank surfaces were prepared in two replicates to give 16 skin-surface contact experiments (4 blanks and 12 spikes) for each skin type. Four skin-surface contacts were performed simultaneously by staggering the start of the contact time by 3 to 5 min. The blank glass surfaces were run parallel with the spiked glass surfaces for the 60-min contact time. The blank metal surfaces were run parallel with the spiked metal surfaces for the 60-min contact time. The glass and metal surfaces for the 1-min contact time were run together as were both surfaces for the 6 x 1 min contact time.

The pig skin experiment was performed first and the data reviewed before proceeding with the human skin experiment. This order was chosen because the pig skin was one quarter the cost of human skin.

Carbon-14 labeled 2,4,5,2',4',5'-hexachlorobiphenyl was used in these experiments. This PCB congener, one of the few available in radio-labeled form, was chosen because it is one of the two available isomers of the highest available homolog. The congener chosen--2,4,5,2',4',5'-hexachlorobiphenyl–-is also representative of real-world spills, since it is a major peak in Aroclor 1260 (about 11%) and in Aroclor 1254 (about 6%) average values obtained on two GC columns for EPA-EMSL-CI repository standards (unpublished data, Michael D. Mullin, USEPA, Gross Ile, Michigan, 1985).

E. Procedures

1. Spiking the Surfaces

The surfaces were spiked on the 2.5 x 2.5 cm (6.25 cm^2) marked area with 100 µL of the ^{14}C-PCB spiking solution. This solution contained 6.25 µg

^{14}C-PCB per 100 µL hexane. Radioactivity in the solution was determined to contain 409,734 to 427,661 disintegrations per minute (dpm) per 100 µL. The solution was spotted in small aliquots using the pipet tip to spread the aliquot in the marked area. The spiked surface was allowed to dry for 30 to 60 s before placing in a closed plastic container (see below: preliminary experiments) to dry for at least 16 h before being contacted with skin.

2. Skin Contact

Pig and human skin was contacted with the ^{14}C-PCB spiked surfaces for 60, 1, and 6 x 1 min under 5 psi (3.2 kg per 9 cm^2). Two replicate blank surfaces, spiked with hexane only, were placed in contact with pig and human skin for 60 min. The outer surface of the skin (3 x 3 cm) was placed over the spiked area (2.5 x 2.5 cm), a clean glass plate was placed over the skin, and a 3.2 kg steel weight was placed on the top glass plate. After the appropriate measured contact time, the weight and the top glass plate were removed. When the top glass plate was removed, the skin usually adhered to it because the inner side of the skin was more oily.

3. Sample Analyses

a. Skin Preparation

The skin was placed in a paper oxidizing cone which was then placed in a scintillation vial for storage (-20°C) until analysis. Preliminary experiments showed that digesting the skin as stated in the work plan of February 14, 1986, was unacceptable; therefore, the skin samples were oxidized (see below: preliminary experiments). The skin samples were oxidized in a Packard Tricarb Sample Oxidizer (Model C306). Permefluor V® (14 ml)in combination with CarboSorb® (7 mL) (Packard Instrument Company) was used as the scintillation cocktail for the oxidized samples.

Before samples were oxidized, ^{14}C recovery was assessed to assure that the instrument was functional. Oxidizing cones containing no radioactivity served as blanks. These blanks gave background counts of ~35.6 cpm. Carbon-14 recovery was assessed using 0.05 mL of ^{14}C-Spec-Chec®

(Packard Instrument Company) spiked in an oxidizing cone, oxidized and counted. The acceptable recovery of these spiked samples was 100% ± 5%.

b. Surface Rinse Preparation

The surfaces were rinsed with toluene (reagent grade) into 50-mL volumetric flasks. The volume was then adjusted to 50 mL. Duplicate aliquots (0.1 mL) of the surface rinses were measured into scintillation vials and 10 mL of Phase Combining Scintillate (Amersham Corporation, Arlington Heights, Illinois) was added. The top glass surface was wiped with a filter paper to determine if the ^{14}C-PCB passed through the skin. The filter paper was then placed in a scintillation vial and 20 mL of toluene-based scintillation fluid* was added.

c. Radioactivity Measurement

Vials were cooled at approximately 4°C for a minimum of 24 h before counting in a refrigerated liquid scintillation counter (Packard Tricarb Model 3255). Correction for background was carried out automatically by the counter. Background determinations were obtained from the average of natural counts of the skin blanks for the oxidized skin samples and of the solvent blanks for surface rinse samples. The counting efficiency was determined using the automatic external standard (AES) method. An AES versus efficiency curve was prepared by processing a quench curve set** through the counter under the conditions used throughout the experiment. Assays outside ± 10% of the mean of the duplicates were reassayed in duplicate.

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* For every 3 L of toluene, the fluid contains:
14.2 g PPO: 2.5 diphenyl-1,3-oxazole
0.8 g POPOP: 1,4-bis-[1-(4-methyl-5-phenyl-1,3-oxazolyl)]-benzene
300 mL PPB-3: Bio-Solv® Beckman Instruments, Fullerton, California

** Amersham Corporation (Arlington Heights, Illinois) manufactures "quench standards." These standards were purchased in 1972. Each standard contains exactly 203,000 dpm, with varying amounts of carbon tetrachloride as the quenching agent. These quench standards are used routinely to calculate counting efficiency.

d. Data Reduction and Reporting

Individual calculations for each sample were performed with an Apple II Plus computer as follows:

(1) Cpm (counts per minute for each sample was converted to dpm (disintegrations per minute).

$$\frac{\text{cpm}}{\text{efficiency}} = \text{dpm/sample}$$

(2) Dpm per mL or g was calculated.

$$\frac{\text{dpm/sample}}{\text{sample weight or aliquot volume (ml)}} = \text{dpm/ml or g}$$

(3) Dpm per mL or g was divided by the specific activity of the compound (dpm/,µg) to obtain the µg/mL or g.

$$\frac{\text{dpm/ml or g}}{\text{specific activity}} = \text{ug/mL or g}$$

(4) This was multiplied by the total volume of the rinsate or weight of the skin sample in order to obtain the total amounts (in µg PCB) in the skin sample or rinsate.

(µg/ml or g)x (total volume)= µg/skin sample or rinsate

(5) The µg/skin sample or rinsate was divided by the total amount of ^{14}C-PCB applied (in µg) in order to obtain the percentage recovered in the sample.

$$\frac{\text{ug/skin sample or rinsate}}{\text{total sample applied (in ug)}} \text{x } 100 = \text{\% of applied sample}$$

IV. RESULTS

A. Test Compound Analysis

HPLC analysis using ultraviolet detection for the non-labeled PCB standard and the radiolabeled PCB compound both showed elution of a single major peak at approximately the same time (10.3 min). Based on the ultraviolet analysis of the radiolabeled compound the chemical purity was greater than 97.5%. Based on the radiochemical analysis the radiochemical purity was 98.8%.

B. Preliminary Experiments

Preliminary studies were conducted to test the experimental conditions. An initial experiment with pig skin contacting replicate ^{14}C-PCB spiked glass surfaces for 60 min demonstrated that only approximately one-half of the applied radioactivity was recovered from the skin and rinse of the glass surface. To further investigate these low total recoveries (52% and 51%), 15 x 24 mm glass coverslips (replicates for each time interval) were spiked with 10 µL of the ^{14}C-PCB solution and left to dry in the hood (hood face velocity was ~ 140 ft/min and the temperature in the hood was ~ 22-24°C) for 0, 1, 2, 4, 6, 8, 24, and 48 h. At the appropriate time intervals, the remaining radioactivity on the coverslip was determined by placing it in a vial with toluene cocktail and counting. The results presented in Table 1 show a considerable decrease in the amount of radioactivity during a 48-h time period. These results prompted an experiment with spiked cover-slips placed in capped vials and dried overnight. The recoveries for this experiment were essentially 100%.

Next, replicate ^{14}C-PCB spiked glass and metal surfaces were dried for at least 16 h in a closed plastic container. Pig skin was placed in contact with the surfaces for 60 min. The results showed recoveries of the applied radioactivity from both types to be essentially 100% (100% and 103% for glass, 98% and 102% for metal). The method blanks contained < 0.1% of the

Table 1. ^{14}C-PCB Loss from Glass Coverslips[a]

Time (h)	Percent of time zero
0	100
1	103
2	101
4	93
6	92
8	74
24	69
48	56

[a]Coverslips spiked with 10 µL ^{14}C-PCB, dried for the indicated time in the hood, then counted by liquid scintillation.

radioactivity in the spiking solution. Therefore, in subsequent experiments, a deviation from the work plan was approved by the study leader, where spiked and blank surfaces were dried in a closed plastic container for at least 16 h.

Preliminary experiments also showed that digesting the skin with 70% perchloric acid and decolorizing with 30% hydrogen peroxide as stated in the work plan was unacceptable. The skin did not completely digest and when scintillation cocktail was added to the digestate, it became very viscous and contained particulate material. This solution needed to be diluted several times to achieve an acceptable counting efficiency. Preliminary experiments demonstrated that oxidizing the skin as a single sample was an acceptable alternative because the sample burned completely in the oxidizer and when counted by liquid scintillation gave an acceptable counting efficiency. The study leader authorized this second deviation from the work plan.

C. Pig Skin

The results from pig skin contacted with glass and metal is presented in Table 2. Approximately 32% of the applied ^{14}C-PCB was transferred from glass surfaces to skin after the 60-min contact, ~ 21% after the 1-min contact, and ~ 44% after the 6 x 1 min contact. From metal surfaces, ~ 16% was transferred to skin after 60 min, 6% after 1 min, and 35% after 6 x 1 min. In general, more of the applied ^{14}C-PCB sample was transferred from the glass surfaces than the metal surfaces. For both glass and metal surfaces, the greatest pickup of the ^{14}C-PCB was during the 6 x 1 min contact periods and the least pickup occurred from contact with the surface for 1 min. The total recoveries (sum of the recovery from the skin plus the surface rinse) ranged from 87 to 96% with a mean total recovery of 93% ± 3%, demonstrating that little or none of the radioactivity was lost. The percent recovery from the filter paper wipes of the top glass plate were < 1% in all cases, indicating that little of the ^{14}C-PCB passed through the skin.

Table 2. Transfer of PCBs from Glass or Painted Metal to Pig Skin

Surface No.	Surface	Skin Surface Contact time (a)	Percent of Applied Sample (b)	Percent of Applied Sample (b)	Percent of Applied Sample (b)
			Skin	Rinse	Total (c)
20	Glass PCB	60 min	35	54	89
21	Glass PCB	60 min	29	64	93
22	Glass PCB	1 min	15	81	96
23	Glass PCB	1 min	27	69	96
24	Glass PCB	6 x 1 min	48	39	87
25	Glass PCB	6 x 1 min	40	50	90
26	Glass Blank	60 min	<0.1	<0.01	<0.1
27	Glass Blank	60 min	<0.1	<0.01	<0.1
28	Metal PCB	60 min	12	84	96
29	Metal PCB	60 min	21	75	96
30	Metal PCB	1 min	6	90	96
31	Metal PCB	1 min	7	88	95
32	Metal PCB	6 x 1 min	34	57	91
33	Metal PCB	6 x 1 min	36	58	94
34	Metal Blank	60 min	<0.1	<0.01	<0.1
35	Metal Blank	60 min	<0.1	<0.01	<0.1

(a) Contact under a static load of 3.2 kg/9cm^2.

(b) Applied sample was spiked on the glass and metal surfaces at 6.25 µg/^{14}C-PCB per 100 µL.

(c) Total is the sum of skin and rinse percents but does not include the percent recovery from a filter paper wipe of the top glass plate because this recovery was < 1% for all surfaces.

D. Human Skin

The results from human skin contacted with glass and metal are presented in Table 3. Since some of the total recoveries were low for human skin contacted with spiked glass surfaces, the experiment was repeated and these results are shown in Table 4. From glass surfaces (Tables 3 and 4), 63-84% of the applied radioactivity was transferred during a 60-min contact period, 35-64% in 1 min, and 22-52% after the 6 x 1 min contact periods. Transfer from metal surfaces was less than from glass surfaces: ~ 48% was transferred in 60 min, ~ 34% in 1 min, and ~ 32% after the 6 x 1 min contact periods. The greatest pickup of the ^{14}C-PCB was during the 60-min contact period.

The total recoveries (sum of the recovery from the skin plus the surface rinse) were 78 ± 13% from the glass surfaces (surfaces no. 40-5), 89 ± 9% from the repeat study with glass surfaces (surfaces no. 58-63), and 89 ± 3% from the metal surfaces (surfaces no. 48-53). The percent recovery from the filter paper wipes of the top glass plate were < 1% in all cases (except surface No. 43 which was 1.5%) indicating that little of the ^{14}C-PCB passed through the skin.

E. Comparison of Pig and Human Skin

In general, a larger amount of the ^{14}C-PCB was transferred from both types of surfaces to the human skin than to the pig skin for all the contact times. The exception to this was one of the replicates (surface 52) for the human skin on a metal surface for 6 x 1 min. The amount transferred to the human skin from surface 52 was lower than either pig skin replicate under the same conditions (20% for the human skin versus 34 and 35% for the pig skin). Based on this experiment data, the pig skin picked up the largest amount of the ^{14}C-PCB in the 6 x 1 min contact time whereas the human skin picked up the largest amount in the 60-min contact time. Both types of skin contained larger amounts of the ^{14}C-PCB after contact with glass surfaces than the metal surfaces.

Table 3. Transfer of PCBs from Glass or Painted Metal to Human Skin

Surface No.	Surface	Skin Surface Contact Time (a)	Percent of Applied Sample (b)	Percent of Applied Sample (b)	Percent of Applied Sample (b)
			Skin	Rinse	Total (c)
40	Glass PCB	60 min	63	16	79
41	Glass PCB	60 min	83	6	89
42	Glass PCB	1 min	56	19	75
43	Glass PCB	1 min	64	10	74
44	Glass PCB	6 x 1 min	52	11	63
45	Glass PCB	6 x 1 min	22	68	90
46	Glass Blank	60 min	<0.1	<0.01	<0.1
47	Glass Blank	60 min	<0.1	<0.01	<0.1
48	Metal PCB	60 min	52	36	88
49	Metal PCB	60 min	44	44	88
50	Metal PCB	1 min	39	48	87
51	Metal PCB	1 min	30	58	88
52	Metal PCB	6 x 1 min	20	74	94
53	Metal PCB	6 x 1 min	45	44	89
54	Metal Blank	60 min	<0.1	<0.01	<0.1
55	Metal Blank	60 min	<0.1	<0.01	<0.1

(a) Contact under a static load of 3.2 kg/9 cm^2.
(b) Applied sample was spiked on the glass and metal surfaces at 6.25 µg ^{14}C-PCB per 100 µL.
(c) Total is the sum of skin and rinse percents but does not include the percent recovery from a filter paper wipe of the top glass plate because this recovery was <1% for all surfaces except surface 43 (percent recovery of filter paper for surface 43 was 1.5%).

Table 4. Transfer of PCBs from Glass to Human Skin

Surface No.	Surface	Skin Surface Contact Time (a)	Percent of Applied Sample (b)	Percent of Applied Sample (b)	Percent of Applied Sample (b)
			Skin	Rinse	Total (c)
58	Glass PCB	60 min	75	6	81
59	Glass PCB	60 min	84	10	94
60	Glass PCB	1 min	35	46	81
61	Glass PCB	1 min	38	47	85
62	Glass PCB	6 x 1 min	52	45	97
63	Glass PCB	6 x 1 min	42	55	97
56	Glass Blank	60 min	<0.1	<0.01	<0.1
57	Glass Blank	60 min	<0.1	<0.01	<0.1

(a) Contact under a static load of 3.2 kg/9 cm^2.
(b) Applied sample was spiked on the glass and metal surfaces at 6.25 µg ^{14}C-PCB per 100 µL.
(c)Total is the sum of skin and rinse percents but does not include the percent recovery from a filter paper wipe of the top glass plate because this recovery was < 1% for all surfaces.

V. CONCLUSIONS AND RECOMMENDATIONS

The *in vitro* transfer of ^{14}C-PCB from glass and painted steel surfaces to skin was considerable under these experimental conditions. The skin samples, generally, picked up more of the applied radioactivity from the glass surfaces than from the metal surfaces.

These results indicate trends and differences between surfaces and skin types; however, because of the variability among a limited data set, the observed differences may not be statistically significant. A statistical analysis is underway and will be reported when completed.

An *in vivo* dermal transfer experiment could be conducted to determine if *in vivo* and *in vitro* amounts of PCBs transferred from the surfaces to the skin would correlate. An *in vivo* dermal transfer experiment could be accomplished by exposing anesthetized rats to a ^{14}C-PCB spiked surface. The animals would be sacrificed and the exposed skin removed for analysis.

Further, *in vitro* dermal transfer studies could be conducted to include other surfaces, especially rough or porous ones, different pressures and time conditions, and other PCB congeners.

The loss of ^{14}C-PCB observed in the preliminary experiments could be further examined by characterizing the rate of evaporative losses for various surfaces.

VI. INTERNAL QUALITY CONTROL

Internal quality control measures followed those outlined in the Work Plan (Dermal Transfer of PCBs from Surfaces, dated February 14, 1986).^{14}C-PCB solution standards, method blanks, solvent blanks, and ^{14}C-PCB spiked skin samples (method spikes) were analyzed along with the samples.

A. Solution Standards

A solution standard was measured after every fourth surface spike with ^{14}C-PCB solution by placing 100 µL of the spiking solution into a scintillation vial for direct counting. The theoretical dpm value for 100 µL of the ^{14}C-PCB solution was 362,000 dpm. The mean dpm of the standards for the human skin experiment was 409,734 ± 1% (113% of the theoretical dpm value); for the repeat human skin experiment, the mean dpm of the standards was 427,661 ± 1% (118% of the theoretical dpm value); and for the pig skin experiment, the mean dpm of the standards was 419,130 ± 1% (116% of the theoretical dpm value). The higher standard values than theoretical value were probably due to evaporation of the spiking solution solvent. For this work, the slightly higher standard values than theoretical value were judged as acceptable.

B. Blanks

Blank pig and human skin samples were oxidized and counted by liquid scintillation. These blank skins had background radioactivity corresponding to less than 0.01% of the radioactivity in the ^{14}C-PCB solution standards. The background counts for the blank skins was ~ 35.6 cpm. The method blanks run along with the spiked surfaces were pig and human skins that were contacted with glass or metal surfaces for 60 min and then oxidized. The method blanks all had less than 0.1% of the solution standard spike radioactivity present in the skins and less than 0.01% present in the toluene rinse of the surface. The solvent and cocktail blanks contained normal background counts of ~ 25 cpm.

C. Method Spikes

Method spiked skin samples consisted of 3 x 3 cm pieces of skin placed into oxidizing cone and spiked directly with the ^{14}C-PCB solution. The skins were oxidized and counted by liquid scintillation. Initially 100 µL of the ^{14}C-PCB solution was used as the volume for spiking. Since the

^{14}C-PCB was prepared in hexane, a volatile solvent, the 100 µL appeared to cause the skin sample to burn unevenly. Therefore, 10 µL samples were used to prevent uneven burns. The pig skin spiked with 100 µL of the ^{14}C-PCB spiking solution gave an average recovery of 89% (83 and 95%). Human skin spiked with 100 µL of the ^{14}C-PCB gave an average recovery of 82% (82 and 81%). Human skin spiked with 10 µL of the ^{14}C-PCB solution had a mean recovery of 87% ± 8%.

D. Duplicate Samples and Replicate Surfaces

The skin samples were not analyzed in duplicate due to technical difficulties described earlier. The entire skin sample was oxidized and counted as one sample. Each surface rinse was sampled and analyzed in duplicate. The data presented in Tables 2-4 represents the average recovery in the rinse for each surface. The duplicate rinse values for each surface were within 5% of the mean of the two samples.

All of the surfaces were prepared in replicate. Some of the replicates did not agree well. These differences are attributed mostly to the variations of the skin. The skin, especially the human skin, was variable from package to package. Some of the pig skin pieces had small pin-point holes in them. In general, the pig skin was consistent in its thickness and had an oily texture. The human skin was very variable in its thickness and the edges of the skin piece had a tendency to curl up. To circumvent this problem, the skin was spread on the top glass surface (inner side of the skin against the top glass plate) first and then positioned on the bottom surface with the outer side of the skin contacting the spiked area.

VII. QUALITY ASSURANCE

A systems audit (March 10, 1986), data audit (March 27, 1986) and report review (March 27, 1986) were used to assess the quality of the data in this report. The systems audit was an on-site qualitative review of the training, standard operating procedures, record keeping, and data validation

aspects of the work assignment. The data was audited to determine its validity. Finally, the report was reviewed for completeness and accuracy of the data.

The results of the systems audit were sent to the MRI work assignment management on March 20, 1986, and the result of the data audit was sent on March 27, 1984. During the systems audit, two approved deviations from the worked plan was noted. The data audit included the original identification and radiochemical and chemical purity of the carbon-14 labeled 2,4,5,2',4',5'-hexachlorobiphenyl and the analysis of the dermal transfer samples. No problems were found that would significantly affect the reported data.

VIII. REFERENCES

1. Erickson MD, Kelso GL, Boggess K. 1986. Evaluation of performance - based cleanup of PCB spills on nonporous surfaces. Draft interim report no. 4, task 37. U.S. Environmental Protection Agency, Office of Toxic Substances.

2. Erickson MD, Boggess K, Long J. 1986. Evaluation of performance-based cleanup of PCB spills on surfaces--part 2, kerosene. Draft interim report no. 6, task 37. U.S. Environmental Protection Agency, Office of Toxic Substances.